

REMARKS

The Office Action dated September 14, 2004 has been received and its contents carefully noted. By this amendment claim 3, 4 and 6-8 have been cancelled in favor of new claims 9-19. Accordingly, claims 9-19 are presently pending in the present application, of which claim 9 is independent.

Initially, Applicant wishes to acknowledge the Examiner's confirmation on page 2 of the Office Action that a certified copy of Applicant's priority document has been filed in the parent application and that Applicant's claim for priority is now complete.

Turning now to paragraph 5 of the Office Action, claims 3, 6 and 7 have been rejected under 35 U.S.C. § 102(e), as being anticipated by U.S. Patent No. 5,969,422 issued to Ting et al. This rejection is respectfully traverse in that the patent to Ting et al. neither discloses nor suggests that which is presently set forth by Applicant's claimed invention.

As can be seen from the foregoing amendments, new independent claim 9 recites a method for manufacturing a semiconductor device which includes the steps of forming a recess in an insulating film on a substrate, depositing a first conductive film in contact with a bottom and side surface of the recess, the conductive film comprising a copper alloy including at least one of Al, Si, Ir and Ru, forming an oxide metal including at least one of Al, Si, Ir and Ru, which is formed by oxidizing a surface portion of the first conductive film, forming a second conductive film on the first conductive film by an electrode plating method so as to fill the recess, the second conductive film including copper, and forming a wire structure which the first conductive film and the second conductive film are integrated. That is, in accordance with the present invention, a novel feature resides in using an oxidation-resistance copper alloy (for example a copper alloy including Al, Si, Ir or Ru as a seed layer deposited on an insulating film). Consequently, in accordance with the present invention, a

conductive film can be formed on the seed layer in a recess by using an electroplating method. Additionally, degradation in the reliability of a wiring due to oxidation of copper included in the seed layer or the like can also be prevented. Support for this subject matter is clearly set forth in Applicant's specification at page 6, line 11 to page 7, line 11.

With this in mind, it is noted that the Examiner states that Ting et al. show all the aspects of the invention including forming a recess, depositing a first conductive film, forming a second conductive film and subsequently integrating the first and second conductive films to form a third conductive film. However, the object of the patent to Ting et al. is to improve the reliability of the wiring as noted in column 6, lines 9-26. Furthermore, Ting et al. teaches forming a seed layer directly on an insulating film as noted in column 8, line 65 to column 9, line 9. However, it is clear that Ting et al. fail to disclose or remotely suggest forming an oxide metal including at least one of Al, Si, Ir and Ru, which is formed by oxidizing a surface portion of the first conductive film as is recited by Applicant's claimed invention. In accordance with the present invention, after forming the seed layer, the surface of the seed layer is exposed to the air during the transferring of the substrate to the plating apparatus. As a result, the surface portion of the seed layer is being oxidized to form the oxide metal. In addition, besides copper, the seed layer includes at least one of Al, Si, Ir and Ru. Furthermore, as the Examiner can readily appreciate, the energy of formation of copper is higher than those of Al, Si, Ir and Ru. For example, the free energy of formation of Cu_2O is -7cal/g while that of SiO_2 is -197.5cal/g and that of Al_2O_3 is -260cal/g. Hence, Al, Si, Ir and Ru having a smaller free energy of formation will be oxidized faster than Cu. As a result, by adding Al, Si, Ir or Ru to copper, since Al, Si, Ir or Ru oxidizes faster than copper, oxidization of copper becomes more difficult, thus the decrease in conductivity of the copper, which is a main material of the seed layer, can be prevented. Further, it is preferred to add Ir

or Ru to Cu in that Ir and Ru do not lose their conductivity after oxidization. However, in accordance with Applicant's present invention, Al, Si, Ir or Ru all satisfy the requirements of the present invention.

As noted hereinabove, Ting et al. teaches "forming a seed layer directly on an insulating film" and "the seed layer includes Ru"; however, this reference clearly fails to teach or suggest the novel feature set forth in accordance Applicant's claimed invention. That is, as is specifically recited in independent claim 9, after forming the copper seed layer, the present invention forms the oxide metal of Al, Si, Ir or Ru, which is added to the Cu seed layer, on the surface of the seed layer. Further, Ting et al. fails to disclose or suggest the difference in oxidization rates between Copper and Al, Si, Ir or Ru and hence, clearly fails to anticipate that which is presently set forth by Applicant's claimed invention. Accordingly, it is respectfully submitted that independent claim 9 as well as those claims which depend therefrom clearly distinguish over the teachings of Ting et al. and are in proper condition for allowance.

With reference now to paragraph 7 of the Office Action, claim 4 has been rejected under 35 U.S.C. §130(a) as being unpatentable over Ting et al. in view of U.S. Patent No. 6,077,782 issued to Hsu et al. This rejection is likewise respectfully traversed in that the patent to Hsu et al. fails to overcome the aforementioned shortcomings associated with the teachings of Ting et al.

That is, Hsu et al. fails to disclose the feature of the present invention of forming an oxide metal including at least one of Al, Si, Ir and Ru, which is formed by oxidizing a surface portion of the first conductive film. Moreover, the disclosure of Hsu et al. relates to a wiring structure using a barrier metal composed of TiN and Ti consequently, Hsu et al. clearly fails

to teach or suggest “depositing a first conductive film in contact with a bottom and side surface of the recess”.

Furthermore, it is noted that Hsu et al. discloses plane orientations. Specifically, Hsu et al. discloses a sandwiching of the TiN (111) between the Al (111) and the Ti (002) to improve the adhesiveness between Al (111) and the Ti (002) as noted in column 3, lines 4-12. Hsu et al. also discloses using copper as a conductive film for wiring. Specifically, Hsu et al. discloses that even in the case where the structure of the above mentioned plane orientation is applied to copper, an effect which is the same as that when the Ti and TiN are combined can be achieved as noted from column 7, line 49 to column 8, line 3. However, Hsu et al. fails to teach or suggest improving the orientation of the copper plating film when the plane orientation of the copper seed layer of the present invention including Al, Si, Ir or Ru is (111). Accordingly, it is respectfully submitted that Applicant’s claimed invention is neither disclosed in nor remotely suggested by the combination proposed by the Examiner.

Referring now to paragraph 8 of the Office Action, previous claim 8 has been rejected under 35 U.S.C. §103(a) as being unpatentable over Ting et al. in view of U.S. Patent No. 6,181,012 issued to Edelstein et al. This rejection is likewise respectfully traversed in that the patent to Edelstein et al. fails to overcome the aforementioned shortcomings associated with the teachings of Ting et al.

Specifically, Edelstein et al. fail to disclose the feature of the present invention which includes forming an oxidized metal including at least one of Al, Si, Ir and Ru which is formed by oxidizing a surface portion of the first conductive film. Further, the disclosure of Edelstein et al. relates to a wiring structure using a barrier metal, and Edelstein et al. fails to teach or suggest the feature of the present invention which includes depositing a first conductive film in contact with a bottom and side surface of the recess. Accordingly, it is

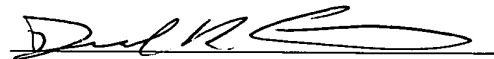
respectfully submitted that Applicant's claimed invention as recited in independent claim 9 is neither disclosed in nor remotely suggested by the combination proposed by the Examiner.

Accordingly, it is respectfully submitted that Applicant's claimed invention as set forth in independent claim 9 as well as those claims which depend therefrom clearly distinguish over the teachings of Ting et al. when taken alone or in view of the teachings of Hsu et al. and/or Edelstein et al. and are in proper condition for allowance

Therefore, in view of the foregoing it is respectfully requested that the rejections of record be reconsidered and withdrawn by the Examiner, that claims 9-19 be allowed and that the application be passed to issue.

Should the Examiner believe a conference would be of benefit in expediting the prosecution of the instant application, he is hereby invited to telephone counsel to arrange such a conference.

Respectfully submitted,



Donald R. Studebaker
Reg. No. 32,815

Nixon Peabody LLP
401 9th Street N.W.
Suite 900
Washington, D. C. 20004
(202) 585-8000